(12) UK Patent Application (19) GB (11) 2 262 349 (13) A

(43) Date of A publication 16.06.1993

(21) Application No 9124795.7

(22) Date of filing 22.11.1991

(51) INT CL[5]
G01R 31/36 19/00

(52) UK CL (Edition L)
G1U UR1900 UR3136

(56) Documents cited
GB 2219408 A WO 88/09489 A1 WO 79/00389 A1

(58) Field of search
UK CL (Edition K) G1U UR1300 UR1900 UR3136
INT CL[5] G01R 13/00 19/00 31/36
Online databases: WPI

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(54) **Battery test circuit**

(57) A battery test circuit comprises a voltage controlled oscillator (13) coupled to a battery (11) for providing a control signal indicative of the battery voltage to an audible signal means (16), the audible signal means (16) thereupon emitting a first audible signal indicative of battery voltage; and this signal may be compared with a second audible signal generated by using a fixed frequency oscillator (15) whereby to assess the charge in the battery.

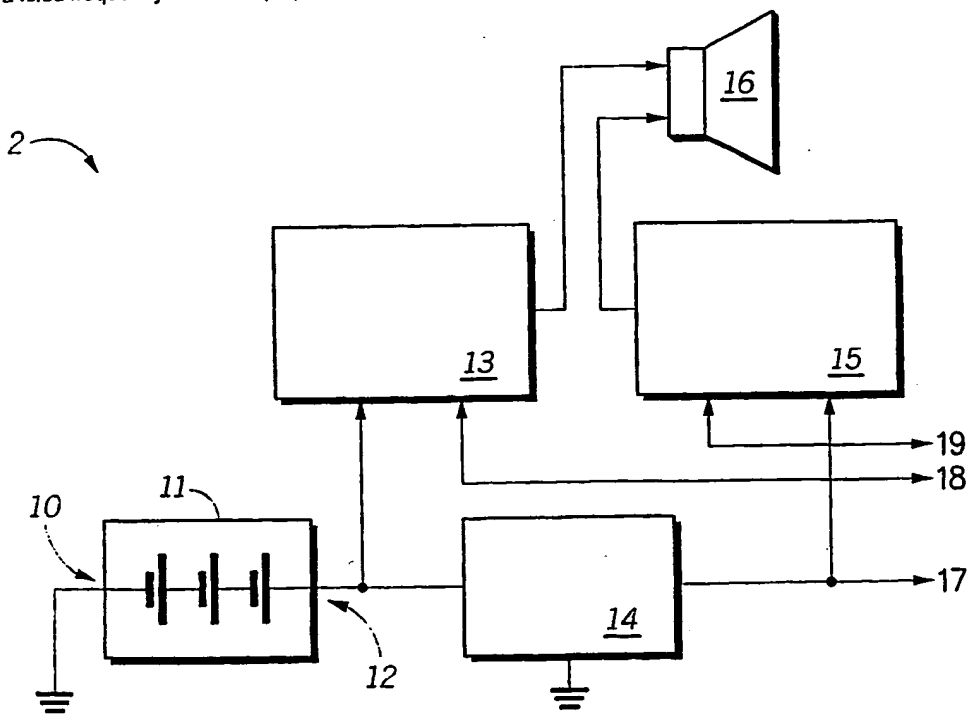

FIG.1

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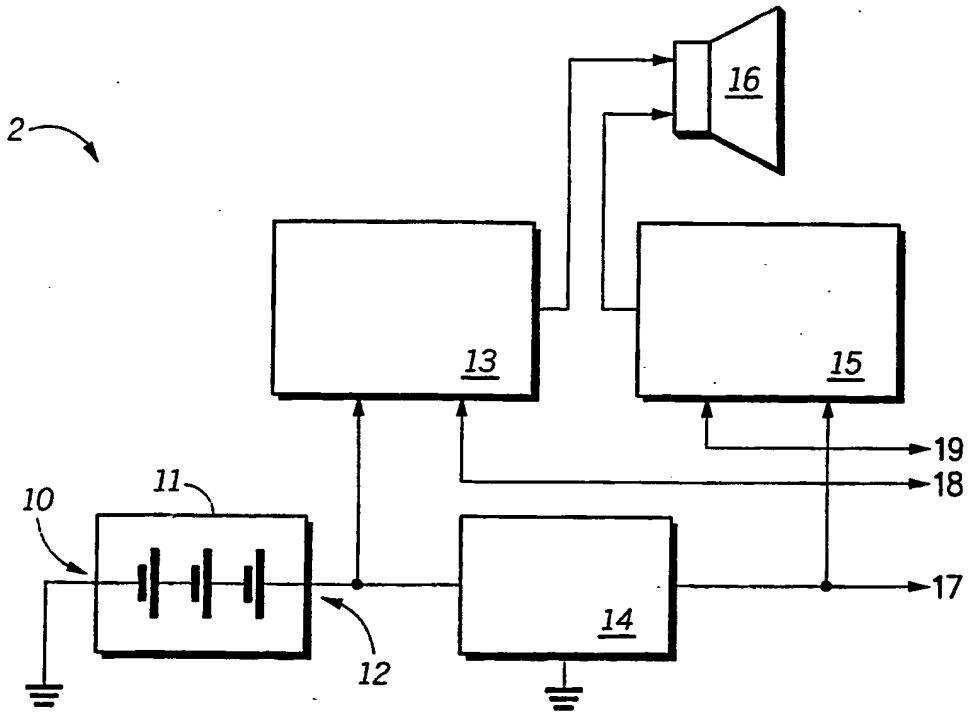
2
16
13
15
19
18
10
11
17
14
12

FIG.1

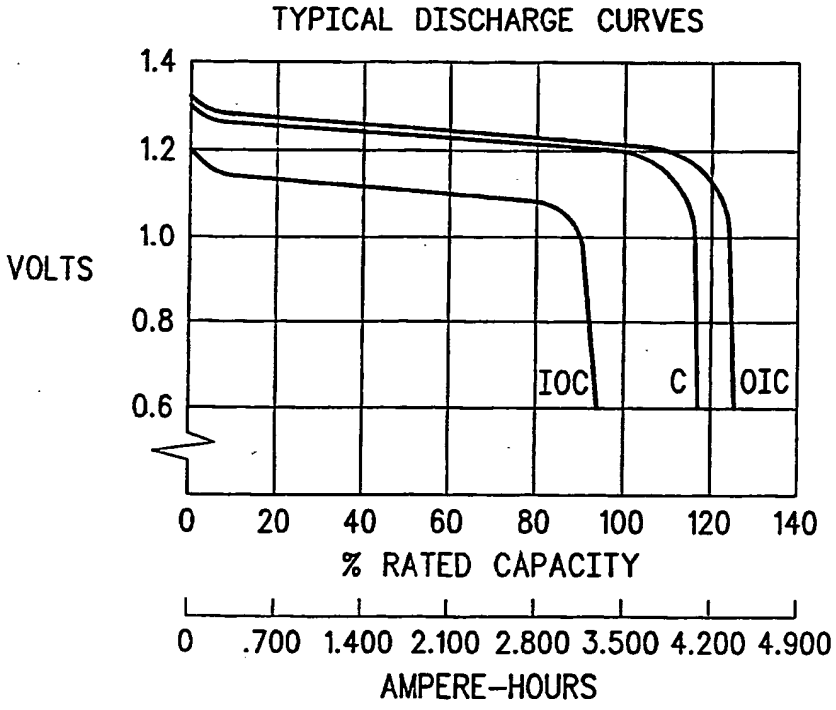
TYPICAL DISCHARGE CURVES
VOLTS
1.4
1.2
1.0
0.8
0.6
IOC
C
OIC
0
20
40
60
80
100
120
140
% RATED CAPACITY
0
.700
1.400
2.100
2.800
3.500
4.200
4.900
AMPERE-HOURS

FIG.2

BATTERY CHARGE INDICATOR CIRCUIT

FIELD OF THE INVENTION

This invention relates to a battery charge indicator circuit.

BACKGROUND OF THE INVENTION

Battery powered devices remain operational as long as there is sufficient charge stored in their battery or batteries. The length of time for which a battery powered device remains operational can be determined from the amount of charge stored in its battery or batteries at a given time. Battery test units can be used to provide to a user of the battery powered device an indication of the amount of charge stored in the battery, and thus, can be used to provide an indication of the amount of time remaining for which the device will be functional.

Known battery test units, however, can be cumbersome to use since to test the battery of the device, the user must carry the battery test unit, or have access to a test unit, in addition to the device.

Some battery powered devices include a low battery warning facility (typically a L.E.D.). A problem with this facility is that it does not provide a comprehensive indication of the remaining charge in the battery, as does the battery test device, but merely provides a warning of when the charge is very low.

This invention seeks to provide a battery indicator circuit in which the above mentioned disadvantages are mitigated.

SUMMARY OF THE INVENTION

According to the present invention there is provided a battery charge indicator circuit for use with a battery comprising:

means for providing first and second audible signals, each signal having a parameter; the parameter of one of the audible signals having a fixed reference value; and

control means coupled to the battery for monitoring the charge stored in the battery and for providing an output signal indicative of the charge stored in the battery to the audible signal means,

the audible signal means being arranged to vary the value of the parameter of the other audible signal in response to the output signal from the control means, wherein the difference between the first and second audible signal parameter values provides an indication to the user of the charge stored in the battery.

Thus, an advantage of the present invention is that it provides means by which a user can check the length of time for which the battery has enough charge to operate a device without the need for utilising a separate battery test unit

The first and second audible signals are preferably generated sequentially.

Preferably, the parameter of the first and second audible signals includes the frequency of the signals.

An advantage of this preferred arrangement is that since the human ear is sensitive to differences in frequency, a user on hearing the two audible signals can have a direct warning of how close the battery is to be discharged.

Preferably, the control means monitors the charge stored in the battery by referencing the battery terminal voltage.

The control means is preferably a voltage controlled oscillator circuit, wherein the frequency of oscillation forming the output signal is indicative of the battery terminal voltage.

Preferably, the audible signal means comprises a conventional loudspeaker, having two inputs.

The audible signal means may further comprise a fixed oscillator circuit for providing the audible signal with the fixed reference parameter.

BRIEF DESCRIPTION OF THE DRAWING

An exemplary embodiment of the invention will now be described with reference to the drawings in which;

FIG.1 is a block diagram of a battery charge indicator circuit in accordance with the present invention; and

FIG.2 is a graph showing typical battery discharge curves.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to FIG.1, a battery charge indicator circuit 2 in accordance with a preferred embodiment of the invention is shown

for use with a battery 11 having negative and positive terminals coupled between a ground reference 10 and a node 12 respectively. The voltage signal at the node 12 is representative of the voltage across the battery 11.

A voltage controlled oscillator (VCO) 13 is coupled to node 12 for providing an output signal having a frequency proportional to the voltage at the node 12. A voltage regulator 14 is also coupled to the node 12 for providing a regulated voltage output 17, which is the supply voltage for a device (not shown) coupled to the output 17. The device may be a pager, radio or any other battery powered device. A fixed frequency oscillator 15, which is also coupled to receive the regulated voltage output 17, provides an output signal of a fixed frequency. It will be appreciated that the oscillator 15 need not necessarily receive a voltage input from the regulator 14; it may receive a voltage from another source.

A loudspeaker 16 has first and second inputs coupled to receive the output signals from the fixed frequency oscillator 15 and from the VCO 13 respectively. The loudspeaker 16 provides audible output signals in response to the signals it receives at its first and second inputs. The loudspeaker 16 provides a first fixed frequency (pitch) output signal in response to the fixed frequency signal at its first input and a second variable frequency (pitch) output signal in response to the signal from the VCO at its second input. The frequency of the second variable frequency output signal will depend on the frequency of the VCO 13 output signal. Thus, a change in voltage at node 12 will produce a change in the pitch of the second output signal. If the frequency of the VCO output signal

is arranged to be the same as the fixed frequency when the battery is fully charged, then a user, by comparing the pitches of the first and second output signals, has an indication as to the voltage at node 12 and hence as to the charge stored in the battery 11.

Other audible signal output devices may be used in place of the loudspeaker 16; for example, headphones.

A control line 18 couples a system control means (not shown in the diagram) to the VCO 13 and a second control line 19 couples the system control means to the fixed oscillator 15. The system control means controls the operation of the VCO 13 and the fixed oscillator 15 and hence the operation of the battery charge indicator circuit 2. In the preferred embodiment, in response to signals from the system control, the fixed oscillator 15 is activated followed by the VCO 13 whereby the first output signal is generated by the loudspeaker 16 followed by the second output signal. It will be appreciated that the activation sequence may be the other way round, such that the VCO 13 is activated first followed by the fixed oscillator 15. The sequence of activation should be chosen so as to provide the user with a reasonable opportunity to compare the fixed and variable output signals from the loudspeaker 16.

The system control means may be a button arrangement (not shown) on the device to be pushed by a user, which generate signals on the control lines 18 and 19 or a microprocessor which is programmed to do the same.

It will be appreciated that in a device such as a mobile radio unit, a microprocessor is used to provide operation control of the unit. The microprocessor can also be used to control the operation of

the VCO 13 and fixed oscillator 15 and thus, no extra hardware is required to provide the system control means in a mobile radio. However, it will be understood that this invention is not limited to devices with microprocessor control.

The system control means driving the control lines 18 and 19 may be arranged to activate the VCO 13 and fixed oscillator 15 upon a specific instruction. For example, in a mobile radio a command from the microprocessor to the loudspeaker generates an audible signal at the end of a start-up sequence to indicate the completion of the start-up sequence. This same command may be used to instruct the VCO 13 and fixed oscillator 15 to function via the control lines 18 and 19 respectively. In this case, the microprocessor in response to the command sends a first signal to the fixed oscillator 15 via the line 19, waits for a short time and then sends a second signal to the VCO 13 via the line 18. In this manner the two oscillators 13 and 15 are activated sequentially, such that the first output signal is heard, followed after a short interval by the second output signal. In this manner the user, by listening to the two audible output signals, is made aware of the remaining charge stored in the battery, by virtue of the difference in frequency (pitch) between the first and second output signals.

It will be appreciated that although the invention has been described above in relation to comparing the frequencies of the fixed and variable output signals another parameter of the signal, such as amplitude, length of the signal or even the number of repeated short signals, may alternatively be used, wherein the difference in volume, length or number of signals respectively

between the first and second signals provides the information about the remaining charge stored in the battery.

Referring to FIG.1 and FIG.2, the uppermost curve shows an example of a typical battery discharge characteristic, showing terminal voltage as a function of Ampere-hours (Discharge). At the highest voltage (1.3v), which occurs when the battery is fully charged, the VCO 13 is arranged such that the frequency of the VCO output signal to the loudspeaker 16 is the same value as the fixed frequency signal from the oscillator 15 to the loudspeaker 16, such that the first and second output signals from the loudspeaker are of substantially the same frequency.

When the terminal voltage of the battery is less than 1.3v the frequency of the signal from the VCO 13 will correspondingly be less than that of the fixed frequency signal. For example after 3.5 ampere hours of battery use, the terminal voltage will have dropped to 1.2 volts. The frequency of the signal will therefore be 92% of the frequency of the fixed signal. The characteristic of the voltage controlled oscillator may be arranged to vary the frequency over a greater proportional range than the voltage range, such that the slope of the frequency of the variable signal is steeper than that of the terminal voltage, whereby the user is not required to make fine judgements of frequency separation, but can easily judge the remaining charge in the battery.

In summary the invention provides a battery charge indicator circuit which in use is coupled to the battery to monitor the charge stored in the battery. A user can check how close the battery is to being discharged by comparing, for example, the pitch of the first

and second output signals. In a mobile radio, the invention can be easily implemented without requiring significant space since the microprocessor which controls the operation of the mobile radio can provide the system control means. Thus, the invention avoids the need for a user to carry a separate battery test unit.

CLAIMS

1. A battery charge indicator circuit for use with a battery comprising:

means for providing first and second audible signals, each signal having a parameter; the parameter of one of the audible signals having a fixed reference value; and

control means coupled to the battery for monitoring the charge stored in the battery and for providing an output signal indicative of the charge stored in the battery to the audible signal means,

the audible signal means being arranged to vary the value of the parameter of the other audible signal in response to the output signal from the control means, wherein the difference between the first and second audible signal parameter values provides an indication to the user of the charge stored in the battery.

2. The circuit of claim 1 wherein the first and second audible signals are generated sequentially.

3. The circuit of claim 1 or claim 2 wherein the parameter of the first and second audible signals includes the frequency of the signals.

4. The circuit of any preceding claim wherein the control means monitors the charge stored in the battery by referencing the battery terminal voltage.

5. The circuit of claim 4 wherein the control means is a voltage controlled oscillator circuit, wherein the frequency of oscillation forming the output signal is indicative of the battery terminal voltage.

6. The circuit of any preceding claim wherein the audible signal means comprises a conventional loudspeaker, having two inputs.

7. The circuit of any preceding claim wherein the audible signal means further comprises a fixed oscillator circuit for providing the audible signal with the fixed reference parameter.

8. A battery powered radio communication device comprising a battery and a battery charge indicator circuit according to any preceding claim.

9. A battery charge indicator circuit as suitably described with reference to and in accordance with FIG.1 of the drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number: 9124795.7

Relevant Technical fields

(i) UK Cl (Edition K) G1U UR1300, UR1900, UR3136

(ii) Int Cl (Edition 5) G01R 13/00, 19/00, 31/36

Search Examiner: K F J NEAL

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASE: WPI

Date of Search: 6 MARCH 1992

Documents considered relevant following a search in respect of claims 1 TO 9

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 2219408 A AUBREU (whole document)	1, 2, 3, 4
X	WO 88/09489 A1 OMEGA (whole document)	1, 2, 3, 4
X	WO 79/00389 A1 BERENDONK (see abstract)	1, 2, 3, 4, 5

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

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P: Document published on or after the declared priority date but before the filing date of the present application.

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